Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (currently amended) A method for reducing the amount of computations required to create a sound signal representing one or more sounds originating at a plurality of discrete positions in space, where the signal is to be perceived as simulating one or more sounds at one or more selected positions in space with respect to a listener, comprising the steps of:

determining a ~~special~~ spatial characteristic function for a position in space at which sound originating at a plurality of positions in space is to be received, wherein said characteristic function represents a head-related impulse response;

applying said characteristic function as a filter to said signal representing sound to produce a filtered signal; and

converting said filtered signal to a sound wave and producing said sound wave for a listener;

wherein a ~~special~~ spatial characteristic function is determined for a selected number of samples and a selected number of eigen values.

2. (currently amended) The method of claim 1 wherein said characteristic function further comprises information concerning an environment in which sound is to be perceived.

3. (original) The method of claim 1 wherein said characteristic function is a spatial feature extraction and regularization model.

4. (original) The method of claim 3 wherein said spatial feature extraction and regularization model comprises a spatial component and a temporal component.

5. (original) The method of claim 4 wherein said temporal component comprises a summed matrix of a predetermined number of eigen vectors.

6. (original) The method of claim 5 wherein said predetermined number of eigen vectors is of a range from 3 to 16.

7. (original) The method of claim 5 wherein said spatial and temporal components are determined via a Karhunen-Loeve Expansion.

8. (previously presented) A method of reducing the amount of computations required to create a sound signal representing one or more sounds originating at a plurality of discrete positions in space, where the signal is to be perceived as simulating one or more sounds at one or more selected positions in space with respect to a listener, comprising the steps of:

determining a spatial characteristic function for a position in space at which sound originating at a plurality of positions in space is to be received, wherein said characteristic function represents a head-related impulse response;

applying said characteristic function as a filter to said signal representing sound to produce a filtered signal; and

converting said filtered signal to a sound wave and producing said sound wave for a listener;

wherein said spatial characteristic function is determined for a selected number of N samples and a selected number of M eigen values and wherein said model filter function for an azimuth position θ and an elevation position φ of sound originating in a spherical coordinate system about said position of sound measurement as said origin has a form

$$y(n) = \sum_{m=1}^{M}\left[\sum_{k=1}^{K} w_m(\theta_k,\varphi_k)s_k(n)\right]q_m(n) \quad 9(c)$$

where s represents a sound source, K represents a number of independent sound sources, $w_m(\theta,\varphi)$ are weighting factors, and $q_m(n)$ is a vector representing an orthonormal basis for a head-related impluse function.

9. (previously presented) Apparatus for providing sound created by a sound source to a listener which simulates the sound source at a selected position in space with respect to the listener, comprising:

an input for receiving a signal representing sound originating at a plurality of positions in space, said plurality of positions including multiple reflections, multiple sources without reflections, and multiple sources with multiple reflections;

a left channel and a right channel, wherein each channel comprises a filter array for applying a filter to said signal received by said input to provide a filtered signal, said filter comprising a linear function including a spatial component which comprises a head-related impulse response;

an output for converting said filtered signals from said channels to a binaural sound and for producing said sound for a listener.

10. (original) The apparatus of claim 9 wherein said linear function comprises a spatial feature extraction and regularization model.

11. (original) The apparatus of claim 9 wherein said linear function includes a spatial component, said spatial component comprising signal delay and attenuation for simulating reflected sound created by surfaces of a sound reproduction environment.

12. (original) The apparatus of claim 9 wherein said linear function includes a temporal component, said temporal component comprising a summed array of a predetermined number of eigen filters.

13. (previously presented) The apparatus of claim 9 further comprising:

an environment input for receiving information concerning a listening environment to be simulated and relative position of a listener;

a calculator for receiving said information from said environment input, and calculating attenuation and time delays to simulate said environment and said listener position;

wherein said output of said calculator is input into said filter array as factors for said linear function.

14. (original) The apparatus of claim 13 further comprising a summed array of a predetermined number of eigen filters attached to said signal input and receiving the signal therefrom, wherein said eigen filters introduce time delays into said signal.

15. (previously presented) Apparatus for providing sound created by a sound source to a listener which simulates the sound source at a selected position in space with respect to the listener, comprising:

an input for receiving a signal representing sound originating at a plurality of positions in space, said plurality of positions including multiple reflections, multiple sources without reflections, and multiple sources with multiple reflections;

a left channel and a right channel, wherein each channel comprises a filter array for applying a filter to said signal received by said input to provide a filtered signal, said filter comprising a linear function including a spatial component which comprises a head-related impulse response;

an output for converting said filtered signals from said channels to a binaural sound and for producing said sound for a listener;

an environment input for receiving information concerning a listening environment to be simulated and relative position of a listener;

a calculator for receiving said information from said environment input, and calculating attenuation and time delays to simulate said environment and said listener position, with an output of said calculator is input into said filter array as factors for said linear function;

a summed array of a predetermined number of eigen filters attached to said signal input and receiving said signal therefrom, wherein said eigen filters introduce time delays into said signal;

a plurality of source placement arrays, wherein each source placement array receives said output of a single eigen filter and filters said signal in accordance with a spatial characteristic function and said output of said calculator;

a summer for summing said output of said source placement arrays; and

a timer and delay for receiving said summed output signal from said summer and a delay count from said calculator.

16. (previously presented) An apparatus for providing sounds created by a plurality of sound sources to a listener which simulates the origin of each sound at a selected position in space with respect to the listener, comprising:

an environment input for receiving information concerning a listening environment to be simulated and relative position of a listener;

a calculator for receiving said information from said environment input, and calculating attenuation and time delays to simulate said environment and said listener position;

a signal input for receiving a signal representing sound originating at a plurality of positions in space; and

a left channel and a right channel attached to said calculator and receiving said calculation of attenuation and time delay therefrom, and also attached to said signal input and receiving said sound signal from said signal input, each channel comprising:

a source placement array for filtering said sound signal in accordance with a spatial characteristic function, wherein said spatial characteristic function is a head-related impulse response;

a plurality of eigen filters attached to said source placement array and receiving said signal therefrom, wherein said eigen filters introduce time delays into said signal; and

a signal output for attaching a speaker to said apparatus, attached to said plurality of eigen filters for receiving and summing said signal therefrom.

17. (previously presented) An apparatus for providing sounds created by a plurality of sound sources to a listener which simulates the origin of each sound at a selected position in space with respect to the listener, comprising:

an environment input for receiving information concerning a listening environment to be simulated and relative position of a listener;

a calculator for receiving said information from said environment input, and calculating attenuation and time delays to simulate said environment and said listener position;

a signal input for receiving a signal representing sound originating at a plurality of positions in space;

a left channel and a right channel attached to said calculator and receiving said calculation of attenuation and time delay therefrom, and also attached to said signal input and receiving said sound signal from said signal input, each channel comprising:

> a source placement array for filtering said sound signal in accordance with a spatial characteristic function, wherein said spatial characteristic function is a head-related impulse response;
>
> a plurality of eigen filters attached to said source placement array and receiving said signal therefrom, wherein said eigen filters introduce time delays into said signal; and
>
> a signal output for attaching a speaker to said apparatus, attached to said plurality of eigen filters for receiving and summing said signal therefrom,

a plurality of signal inputs for receiving a plurality of signals representing a plurality of sounds, wherein each channel further comprises a plurality of source placement arrays, each of said source placement arrays mated to a single signal input, and a plurality of summers for receiving and summing said signal from each source placement array and for outputting said summed signal into said temporal filter.

18. (original) The apparatus of claim 16 wherein said plurality of eigen filters is of a range from 3 to 16.

19. (previously presented) The apparatus of claim 16 further comprising a delay buffer for introducing a temporal delay into said signal, wherein said delay buffer receives said signal from said sound input and outputs said delayed signal into each channel.

20. (original) The apparatus of claim 16 wherein said apparatus further comprises a cross-talk canceler for filtering cross-talk in said signal prior to reproduction by said speakers.

21. (previously presented) An apparatus for efficiently simultaneously processing a simulation of a plurality of sound signals in a three dimensional space, each channel within said apparatus comprising:

at least one delayer for delaying a sound source signal;

at least one attenuator for attenuating a sound source signal;

a plurality of filters for filtering said attenuated sound signal;

a plurality of weighting elements to weight said filtered sound signals; and

a summer for summing said filtered sound signals;

wherein said plurality of filters remain constant, with at least one of said at least one delay element, said at least one attenuator, and said plurality of weighting elements adapted to change a perceptive position of said sound source signal to a listener; and

wherein said plurality of sound signals comprise multiple reflections, multiple sources without reflections, and multiple sources with multiple reflections.

22. (canceled)

23. (previously presented) A method for efficiently simultaneously processing a simulation of a plurality of sound signals in a three dimensional space, each channel within said apparatus comprising:

delaying a sound source signal;

attenuating a sound source signal;

filtering said attenuated sound signal;

weighting said filtered sound signals; and

summing said filtered sound signals;

wherein said filtered attenuated sound signal remains constant, with at least one of said delayed sound source signal, said attenuated sound source signal, and said weighted filtered sound signals are adapted to change a perceptive position of said sound source signal to a listener; and

wherein said plurality of sound signals comprise multiple reflections, multiple sources without reflections, and multiple sources with multiple reflections.

24. (canceled)

25. (previously presented) An apparatus for efficiently simultaneously processing a simulation of a plurality of sound signals in a three dimensional space, each channel within said apparatus comprising:

means for delaying a sound source signal;

means for attenuating a sound source signal;

means for filtering said attenuated sound signal;

means for weighting said filtered sound signals; and

means for summing said filtered sound signals;

wherein said means for filtering said attenuated sound signal remains constant, with at least one of said means for delaying said sound source signal, said means for attenuating said sound source signal, and said means for weighting said filtered sound signals are adaptived to change a perceptive position of said sound source signal to a listener; and

wherein said plurality of sound signals include multiple reflections, multiple sources without reflections, and multiple sources with multiple reflections.

26. (canceled)

27. (withdrawn) An apparatus for efficiently simultaneously processing a simulation of a plurality of sound signals in a three dimensional space comprising:

a one source multiple reflection sound processor for processing a single sound source having multiple reflections;

a multiple source without reflections sound processor for processing multiple sound sources having no reflections; and

a multiple source multiple reflections sound processor for processing multiple sound sources having multiple reflections;

wherein said apparatus is adaptively able to switch on and off said one source multiple reflection sound processor, said multiple source without reflections sound processor and said multiple source multiple reflections sound processor.

28. (withdrawn) The apparatus for efficiently simultaneously processing a simulation of a plurality of sound signals in a three dimensional space according to claim 27, further comprising:

a set of eigen filters that collectively represent a bases of at least one of head-related transfer functions and head-related impulse responses.

29. (withdrawn) A method for efficiently simultaneously processing a simulation of a plurality of sound signals in a three dimensional space comprising:

processing a single sound source having multiple reflections;

processing multiple sound sources having no reflections; and

processing multiple sound sources having multiple reflections;

wherein said processed single sound source having multiple reflections, said processed multiple sound sources without reflections and said multiple sound sources having multiple reflections are independently adaptively active.

30. (withdrawn) The method for efficiently simultaneously processing a simulation of a plurality of sound signals in a three dimensional space according to claim 29, further comprising:

eigen filtering representing a bases of at least one of head-related transfer functions or head-related impulse responses.

31. (withdrawn) An apparatus for efficiently simultaneously processing a simulation of a plurality of sound signals in a three dimensional space comprising:

a single sound source having multiple reflections processing means for processing a single sound source having multiple reflections;

a multiple sound sources having no reflections processing means for processing multiple sound sources having no reflections; and

a multiple sound sources having multiple reflections processing means for processing multiple sound sources having multiple reflections;

wherein said means for processing a single sound source having multiple reflections, said means for processing multiple sound sources without reflections and said means for processing multiple sound sources having multiple reflections are independently adaptively activated.

32. (withdrawn) The apparatus for efficiently simultaneously processing a simulation of a plurality of sound signals in a three dimensional space according to claim 31, further comprising:

eigen filtering representing a bases of at least one of head-related transfer functions or head-related impulse responses.

33. (withdrawn) An apparatus for efficiently simultaneously processing a simulation of a plurality of sound signals in a three dimensional space comprising:

a spatial feature extraction and regulation modeler for modeling a three dimensional sound;

wherein when a number of sound sources increases, a number of convolutions performed by said spatial feature extraction and regulation modeler is less than a multiple of a total number of sound sources.

34. (withdrawn) The plurality of sound signals according to claim 33 comprising:

multiple reflections, multiple source without reflections and multiple source with multiple reflections.

35. (withdrawn) A method for efficiently simultaneously processing a simulation of a plurality of sound signals in a three dimensional space comprising:

modeling a three dimensional sound through a spatial feature extraction and regulation modeler; and

reducing a number of convolutions performed by said spatial feature extraction and regulation modeler by a value that is less than a multiple of a total number of sound sources when a number of sound sources increases.

36. (withdrawn) The plurality of sound signals according to claim 35, comprising:

multiple reflections, multiple source without reflections and multiple source with multiple reflections.

37. (withdrawn) An apparatus for efficiently simultaneously processing a simulation of a plurality of sound signals in a three dimensional space comprising:

modeling means for modeling a three dimensional sound through a spatial feature extraction and regulation modeler; and

reducing means for reducing a number of convolutions performed by said spatial feature extraction and regulation modeler by a value that is less than a multiple of a total number of sound sources when a number of sound sources increases.

38. (withdrawn) The plurality of sound signals according to claim 37, comprising:

multiple reflections, multiple source without reflections and multiple source with multiple reflections.

39. (withdrawn; previously presented) An apparatus for efficiently simultaneously processing a simulation of a plurality of sound signals in a three dimensional space comprising:

a processor for processing said plurality of sound signals;

wherein an output of said processor is based on functions:

$$\begin{aligned} y(n) &= s_1(n) * h(n,\theta_1,\varphi_1) + s_2(n) * h(n,\theta_2,\varphi_2) && (8a) \\ &= s_1(n) * \sum_{m=1}^{M} w_m(\theta_1,\varphi_1) q_m(n) + s_2(n) * \sum_{m=1}^{M} w_m(\theta_2,\varphi_2) q_m(n) && (8b) \\ &= \sum_{m=1}^{M} \left[w_m(\theta_1,\varphi_1) s_1(n) + w_m(\theta_2,\varphi_2) s_2(n) \right] * q_m(n) && (8c) \end{aligned}$$

where $h(n,\theta,\varphi)$ represents head-related impulse responses, $s_x(n)$ represents sound signals at different directions, $w_m(\theta_x,\varphi_x)$ represents weight functions, $q_m(n)$ represents eigen filters, and M represents ~~the~~ dimensions of a subspace.

40. (withdrawn) The plurality of sound signals according to claim 39, comprising:

multiple reflections, multiple source without reflections and multiple source with multiple reflections.

41. (withdrawn) The apparatus for efficiently simultaneously processing a simulation of a plurality of sound signals according to claim 39, wherein:

said plurality of eigen filters is of a range from 3 to 16.

42. (withdrawn) A method for efficiently simultaneously processing a simulation of a plurality of sound signals in a three dimensional space comprising:

processing said plurality of sound signals;

outputting based on functions:

$$\begin{aligned} y(n) &= s_1(n) * h(n,\theta_1,\varphi_1) + s_2(n) * h(n,\theta_2,\varphi_2) && (8a) \\ &= s_1(n) * \sum_{m=1}^{M} w_m(\theta_1,\varphi_1) q_m(n) + s_2(n) * \sum_{m=1}^{M} w_m(\theta_2,\varphi_2) q_m(n) && (8b) \\ &= \sum_{m=1}^{M} \left[w_m(\theta_1,\varphi_1) s_1(n) + w_m(\theta_2,\varphi_2) s_2(n) \right] * q_m(n) && (8c) \end{aligned}$$

where $h(n,\theta,\varphi)$ represents head-related impulse responses, $s_x(n)$ represents sound signals at different directions, $w_m(\theta_x,\varphi_x)$ represents weight functions, $q_m(n)$ represents eigen filters, and M represents dimensions of a subspace.

43. (withdrawn) The plurality of sound signals according to claim 42, comprising:

multiple reflections, multiple source without reflections and multiple source with multiple reflections.

44. (withdrawn) The method for efficiently simultaneously processing a simulation of a plurality of sound signals, wherein:

said plurality of eigen filters is of a range from 3 to 16.

45. (withdrawn) An apparatus for efficiently simultaneously processing a simulation of a plurality of sound signals in a three dimensional space comprising:

processing means for processing said plurality of sound signals;

outputting means for outputting based on functions:

$$\begin{aligned} y(n) &= s_1(n) * h(n,\theta_1,\varphi_1) + s_2(n) * h(n,\theta_2,\varphi_2) && (8a) \\ &= s_1(n) * \sum_{m=1}^{M} w_m(\theta_1,\varphi_1) q_m(n) + s_2(n) * \sum_{m=1}^{M} w_m(\theta_2,\varphi_2) q_m(n) && (8b) \\ &= \sum_{m=1}^{M} \left[w_m(\theta_1,\varphi_1) s_1(n) + w_m(\theta_2,\varphi_2) s_2(n) \right] * q_m(n) && (8c) \end{aligned}$$

where $h(n,\theta,\varphi)$ represents head-related impulse responses, $s_x(n)$ represents sound signals at different directions, $w_m(\theta_x,\varphi_x)$ represents weight functions, $q_m(n)$ represents eigen filters, and M represents dimensions of a subspace.

46. (withdrawn) The plurality of sound signals according to claim 45, comprising:

multiple reflections, multiple source without reflections and multiple source with multiple reflections.

47. (withdrawn) The apparatus for efficiently simultaneously processing a simulation of a plurality of sound signals according to claim 45, wherein:

said plurality of eigen filters is of a range from 3 to 16.

48. (withdrawn) An apparatus for efficiently simultaneously processing a simulation of a plurality of sound signals in a three dimensional space comprising:

a processor for processing said plurality of sound signals rendered from a one ear output signal which is a summation of each source convoluted with respective head-related impulse responses;

wherein an output of said processor is based on functions:

$$\begin{aligned} y(n) &= s_1(n) * h(n,\theta_1,\varphi_1) + s_2(n) * h(n,\theta_2,\varphi_2) + \cdots + s_k(n) * h(n,\theta_k,\varphi_k) && (9a) \\ &= \sum_{k=1}^{K} s_k(n) * \sum_{m=1}^{M} w_m(\theta_k,\varphi_k) q_m(n) && (9b) \\ &= \sum_{m=1}^{M} \left[\sum_{k=1}^{K} w_m(\theta_k,\varphi_k) s_k(n) \right] * q_m(n). && (9c) \end{aligned}$$

where k represents independent sound sources at different spatial locations, $h(n,\theta,\varphi)$ represents head-related impulse responses, $s_x(n)$ represents sound signals at different directions, $w_m(\theta_x,\varphi_x)$ represents weight functions, $q_m(n)$ represents eigen filters, and M represents dimensions of a subspace.

49. (withdrawn) The plurality of sound signals according to claim 48, comprising:

multiple reflections, multiple source without reflections and multiple source with multiple reflections.

50. (withdrawn) The apparatus for efficiently simultaneously processing a simulation of a plurality of sound signals according to claim 48, wherein:

said plurality of eigen filters is of a range from 3 to 16.

51. (withdrawn) A method for efficiently simultaneously processing a simulation of a plurality of sound signals in a three dimensional space comprising:

processing said plurality of sound signals rendered from a one ear output signal which is a summation of each source convoluted with respective head-related impulse responses;

outputting based on functions:

$$
\begin{aligned}
y(n) &= s_1(n) * h(n,\theta_1,\varphi_1) + s_2(n) * h(n,\theta_2,\varphi_2) + \cdots + s_k(n) * h(n,\theta_k,\varphi_k) && (9a)\\
&= \sum_{k=1}^{K} s_k(n) * \sum_{m=1}^{M} w_m(\theta_k,\varphi_k) q_m(n) && (9b)\\
&= \sum_{m=1}^{M} \left[\sum_{k=1}^{K} w_m(\theta_k,\varphi_k) s_k(n) \right] * q_m(n). && (9c)
\end{aligned}
$$

where k represents independent sound sources at different spatial locations, $h(n,\theta,\varphi)$ represents head-related impulse responses, $s_x(n)$ represents sound signals at different directions, $w_m(\theta_x,\varphi_x)$ represents weight functions, $q_m(n)$ represents eigen filters, and M represents dimensions of a subspace.

52. (withdrawn) The apparatus for efficiently simultaneously processing a simulation of a plurality of sound signals according to claim 51, wherein:

said plurality of eigen filters is of a range from 3 to 16.

53. (withdrawn) The plurality of sound signals according to claim 51, comprising:

multiple reflections, multiple source without reflections and multiple source with multiple reflections.

54. (withdrawn) An apparatus for efficiently simultaneously processing a simulation of a plurality of sound signals in a three dimensional space comprising:

processing means for processing said plurality of sound signals rendered from a one ear output signal which is a summation of each source convoluted with respective head-related impulse responses;

outputting means for outputting based on functions:

$$\begin{aligned} y(n) &= s_1(n) * h(n,\theta_1,\varphi_1) + s_2(n) * h(n,\theta_2,\varphi_2) + \cdots + s_k(n) * h(n,\theta_k,\varphi_k) & (9a) \\ &= \sum_{k=1}^{K} s_k(n) * \sum_{m=1}^{M} w_m(\theta_k,\varphi_k) q_m(n) & (9b) \\ &= \sum_{m=1}^{M} \left[\sum_{k=1}^{K} w_m(\theta_k,\varphi_k) s_k(n) \right] * q_m(n). & (9c) \end{aligned}$$

where k represents independent sound sources at different spatial locations, $h(n,\theta,\varphi)$ represents head-related impulse responses, $s_x(n)$ represents sound signals at different directions, $w_m(\theta_x,\varphi_x)$ represents weight functions, $q_m(n)$ represents eigen filters, and M represents dimensions of a subspace.

55. (withdrawn) The apparatus for efficiently simultaneously processing a simulation of a plurality of sound signals according to claim 54, wherein:

said plurality of eigen filters is of a range from 3 to 16.

56. (withdrawn) The plurality of sound signals according to claim 54, comprising:

multiple reflections, multiple source without reflections and multiple source with multiple reflections.

57. (withdrawn) An apparatus for efficiently processing a one source sound signal to simulate a three dimensional sound signal comprising:

a processor for processing said one source sound signal;

wherein an output of said processor is based on functions:

$$\begin{aligned} y_L(n) &= s(n) * \sum_{m=1}^{M} w_m(\theta_L, \varphi_L) q_m(n), && (10) \\ &= \sum_{m=1}^{M} \left[w_m(\theta_L, \varphi_L) s(n) \right] * q_m(n), && (10a) \\ &= \sum_{m=1}^{M} \left[s(n) * q_m(n) \right] w_m(\theta_L, \varphi_L), && (10b) \end{aligned}$$

where, $s(n)$ represents a sound signal, $w_m(\theta_x, \varphi_x)$ represents weight functions, $q_m(n)$ represents eigen filters, and M represents dimensions of a subspace.

58. (withdrawn) The plurality of sound signals according to claim 57, comprising:

multiple reflections, multiple source without reflections and multiple source with multiple reflections.

59. (withdrawn) The apparatus for efficiently simultaneously processing a simulation of a plurality of sound signals according to claim 58, wherein:

said plurality of eigen filters is of a range from 3 to 16.

60. (withdrawn) A method for efficiently processing a one source sound signal to simulate a three dimensional sound signal comprising:

processing said one source sound signal;

outputting based on functions:

$$
\begin{aligned}
y_L(n) &= s(n) * \sum_{m=1}^{M} w_m(\theta_L, \varphi_L) q_m(n), && (10)\\
&= \sum_{m=1}^{M} \left[w_m(\theta_L, \varphi_L) s(n) \right] * q_m(n), && (10a)\\
&= \sum_{m=1}^{M} \left[s(n) * q_m(n) \right] w_m(\theta_L, \varphi_L), && (10b)
\end{aligned}
$$

where, $s(n)$ represents a sound signal, $w_m(\theta_x, \varphi_x)$ represents weight functions, $q_m(n)$ represents eigen filters, and M represents dimensions of a subspace.

61. (withdrawn) The plurality of sound signals according to claim 57, comprising:

multiple reflections, multiple source without reflections and multiple source with multiple reflections.

62. (withdrawn) The method for efficiently simultaneously processing a simulation of a plurality of sound signals according to claim 60, wherein:

said plurality of eigen filters is of a range from 3 to 16.

63. (withdrawn) An apparatus for efficiently processing a one source sound signal to simulate a three dimensional sound signal comprising:

processing means for processing said one source sound signal;

outputting means for outputting based on functions:

$$
\begin{aligned}
y_L(n) &= s(n) * \sum_{m=1}^{M} w_m(\Theta_L, \varphi_L) q_m(n), && (10)\\
&= \sum_{m=1}^{M} \left[w_m(\theta_L, \varphi_L) s(n) \right] * q_m(n), && (10a)\\
&= \sum_{m=1}^{M} \left[s(n) * q_m(n) \right] w_m(\theta_L, \varphi_L), && (10b)
\end{aligned}
$$

where, $s(n)$ represents a sound signal, $w_m(\theta_x, \varphi_x)$ represents weight functions, $q_m(n)$ represents eigen filters, and M represents dimensions of a subspace.

64. (withdrawn) The plurality of sound signals according to claim 63, comprising:

multiple reflections, multiple source without reflections and multiple source with multiple reflections.

65. (withdrawn) The apparatus for efficiently simultaneously processing a simulation of a plurality of sound signals according to claim 63, wherein:

said plurality of eigen filters is of a range from 3 to 16.

66. (withdrawn) A method of producing a 3D sound with reduced computations with binaural or speaker presentations with which multiple independent sound sources and reflections of independent sound sources are summed together to create a synthesized 3D audio scene with improved speed and efficiency, comprising the following steps:

determining a set of M eigen filters representing at least one of a measured head-related transfer functions (HRTFs) or head-related impulse responses HRIRs;

determining a set of M spatial characteristics functions (SCFs) linearly combined with said eigen filters to reproduce at least one of said measured HRTFs, and said HRIRs;

interpolating at least one of said HRTFs and said HRIRs in directions where a measurement was not made; and

for each source, said multiple independent sound sources or reflections of independent sound sources, introducing at least one of a delay and a weight;

three dimensionally positioning at least one of said multiple independent sound sources or reflections of independent sound sources by adapting said weight and said delay by a multiple, said multiple derived from sample values of spatial characteristic functions (SCFs) samples obtained through evaluating SCFs at an azimuth and an elevation intended for said source to be positioned. 2xM sub-signals are generated at an end of this step;

for K independent and dependent sound sources, repeat steps introducing at least one of a delay and a weight and three dimensionally positioning to generate 2xKxM sub-signals; and

convolving said sub-signals with 2xM eigen filters to generate 2xM signals, said 2xM signals further regrouped into 2 binaural signals for a left ear and a right ear presentation.

67. (withdrawn) The method of producing a 3D sound according to claim 66, wherein:

said plurality of eigen filters is of a range from 3 to 16.

68. (withdrawn) An apparatus for producing a 3D sound with reduced computations with binaural or speaker presentations with which multiple independent sound sources and reflections of independent sound sources are summed together to create a synthesized 3D audio scene with improved speed and efficiency, comprising the following steps:

a first determiner determining a set of M eigen filters representing at least one of a measured head-related transfer functions (HRTFs) or head-related impulse responses HRIRs;

a second determiner determining a set of M spatial characteristics functions (SCFs) linearly combined with said eigen filters to reproduce at least one of said measured HRTFs, and said HRIRs;

an interpolator interpolating at least one of said HRTFs and said HRIRs in directions where a measurement was not made;

at least one of a delayer and a weighter for at least one of each source, said multiple independent sound sources and reflections of independent sound sources;

a positioner three dimensionally positioning at least one of said multiple independent sound sources or reflections of independent sound sources by adapting said weight and said delay by a multiple, said multiple derived from sample values of spatial characteristic functions (SCFs) samples obtained through evaluating SCFs at an azimuth and an elevation intended for said source to be positioned. 2xM sub-signals are generated at an end of this step;

a repeater repeated utilization for K independent and dependent sound sources said delayer and weighter and said positioner to generate 2xKxM sub-signals; and

a convolver convolving said sub-signals with 2xM eigen filters to generate 2xM signals, said 2xM signals further regrouped into 2 binaural signals for a left ear and a right ear presentation.

69. (withdrawn) The apparatus for producing a 3D sound according to claim 68, wherein:

said plurality of eigen filters is of a range from 3 to 16.

70. (withdrawn) An apparatus for producing a 3D sound with reduced computations with binaural or speaker presentations with which multiple independent sound sources and reflections of independent sound sources are summed together to create a synthesized 3D audio scene with improved speed and efficiency, comprising the following steps:

a first determiner means for determining a set of M eigen filters representing at least one of a measured head-related transfer functions (HRTFs) or head-related impulse responses HRIRs;

a second determiner means for determining a set of M spatial characteristics functions (SCFs) linearly combined with said eigen filters to reproduce at least one of said measured HRTFs, and said HRIRs;

an interpolator means for interpolating at least one of said HRTFs and said HRIRs in directions where a measurement was not made;

at least one of a delayer means and a weighter means for at least one of each source, said multiple independent sound sources and reflections of independent sound sources;

a positioner means for three dimensionally positioning at least one of said multiple independent sound sources or reflections of independent sound sources by adapting said weight and said delay by a multiple, said multiple derived from sample values of spatial characteristic functions (SCFs) samples obtained through evaluating SCFs at an azimuth and an elevation intended for said source to be positioned. 2xM sub-signals are generated at an end of this step;

a repeater means for repeated utilization for K independent and dependent sound sources said delayer means and weighter means and said positioner means to generate 2xKxM sub-signals; and

a convolver means for convolving said sub-signals with 2xM eigen filters to generate 2xM signals, said 2xM signals further regrouped into 2 binaural signals for a left ear and a right ear presentation.

71. (withdrawn) The apparatus for producing a 3D sound according to claim 70, wherein:

said plurality of eigen filters is of a range from 3 to 16.

72. (withdrawn) An apparatus producing a three dimensional sound comprising:

a set of M eigen filters derived from measuring at least one of a head related transfer functions (HRTFs) or head related impulse response (HRIRs) with independence of location of a source;

a set of M delays, multipliers, and spatial characteristic function (SCF) weights;

a set of M combiners;

a summer and regrouper, one said summer and said regrouper for each sound of a sound destination.

73. (withdrawn) The apparatus for producing a 3D sound according to claim 72, wherein:

said plurality of eigen filters is of a range from 3 to 16.

74. (withdrawn) A method for producing a three dimensional sound comprising:

deriving a set of M eigen filters from measuring at least one of a head related transfer functions (HRTFs) or head related impulse response (HRIRs) with independence of location of a source;

setting M delays, multipliers, and spatial characteristic function (SCF) weights;

combining a set of M sounds;

summing and regrouping, summing and regrouping for each sound of a sound destination.

75. (withdrawn) The method of producing a 3D sound according to claim 74, wherein:

said plurality of eigen filters is of a range from 3 to 16.

76. (withdrawn) A method for producing a three dimensional sound comprising:

deriving means for deriving a set of M eigen filters from measuring at least one of a head related transfer functions (HRTFs) or head related impulse response (HRIRs) with independence of location of a source;

setting means for setting M delays, multipliers, and spatial characteristic function (SCF) weights;

combining means for combining a set of M sounds;

summing means and regrouping means for each sound of a sound destination.

77. (withdrawn) The apparatus for producing a 3D sound according to claim 68, wherein:

said plurality of eigen filters is of a range from 3 to 16.